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which, with the Lehrbuch above referred to, form a monumental record of scientific activity. To pass this in review is hardly practicable within the space of a short memorial sketch. He has made contributions to many branches of physical research, and through the "Lehrbuch" and the great variety of apparatus which bears his name, his relation to his chosen science, both in his own country and abroad, has been of the most intimate kind. Rather by way of illustration than with any purpose of presenting an adequate review of his scientific work, certain of his papers may be cited.

In the category of precise physical measurements we may notice first of all his determination of the ohm and a considerable number of papers upon the measurement of the earth's magnetic constants. In the course of these latter studies new methods and new apparatus were developed many of which are still fully equal to the most exacting requirements of modern quantitative science. The determination, in association with his brother Wilhelm, of the electrochemical equivalent of silver also finds a place in this period of his activity.

The name of Kohlrausch is perhaps most familiarly associated with the work on electrical conductivity in solutions which owes its foundation (the applicability of Ohm's Law to conductors of the second class) and much of its modern development (the theory of polarization, dissociation, and ionic conductivity) to the work of Kohlrausch and his pupils, among whom were included Arrhenius, Barus, Nernst, and many others hardly less distinguished.

Arthur L. Day.

## ERASMUS DARWIN LEAVITT (1836–1916)

Fellow of Class I, Section 4, 1878.

Erasmus Darwin Leavitt was born at Lowell, Mass. on October 27, 1836, and died in Cambridge, Mass. on March 11, 1916. He was named for his father, who was given the name because of his father's admiration for Darwin's grandfather.

The public schools of Lowell furnished young Leavitt his education up to the age of fourteen. After that he educated himself for the profession of mechanical engineer, supplementing his work in various machine shops with long and patient study far into the night. To have become, under such conditions, one of the foremost men of the day in his profession, speaks volumes for his grit, pertinacity and ability.

After serving three years as apprentice in the Lowell Machine Shops, he entered the employ of Corliss & Nightingale. In 1858 he served as assistant foreman in the works of Harrison Loring at South Boston, where he had charge of constructing the engine of a United States man-of-war. The next three years found him in Providence, filling the position of chief draftsman for Thurston, Gardner & Co., celebrated at that time as builders of high grade steam engines.

At the outbreak of the Civil War, Leavitt enlisted in the engineers' department of the Navy. He served for nearly three years on the gunboat Sagamore, attached to the Eastern Gulf Squadron; where he reached the grade of second assistant engineer. After this, he was transferred to construction work in several of the United States Navy Yards. In 1865, he was detailed as instructor of steam engineering at Annapolis. Two years later he resigned from the Navy, and opened an office for the practice of mechanical engineering.

One of his first pieces of work, designed for the Plymouth Cordage Co., was a simple condensing walking beam engine, which is still in working order. After the construction of this engine, Mr. Leavitt remained the consulting engineer of the Company until his retirement from business.

It was not long before Mr. Leavitt's engines began to attract wide attention. He had for some time been interested in the economy of pumping engines, and his fame as an engineer may be said to date from the installation of an engine for the Lynn Water Works, embracing all his ideas of efficiency and economy.

Without entering into the details of the construction of this pump, it is sufficient to state that it set a world wide standard for pumping engines. It was officially tested by a number of the best experts of the day, and developed a duty of over 103,900,000 foot pounds per hundred pounds of picked Lackawanna anthracite.

Shortly after this, Mr. Leavitt designed a pair of similar, but somewhat larger pumping engines for Lawrence, Mass.

By 1874 his fame was so well established, that when Mr. Alexander Agassiz was looking about for an engineer to take charge of designing the equipment of the Calumet and Hecla Mine, the latter's choice fell on Mr. Leavitt.

This opened up a wide field for a mechanical engineer. For Mr. Agassiz was looking ahead to the future great development of the mine, and it was his policy to install an equipment for the coming years, and to install it in duplicate, to avoid the loss that would otherwise arise from any delays caused by accidents to the plant.

Mr. Leavitt stood for low speed engines of high economy, and to this end he used a complicated valve gear. The initial cost of such engines was high, but he always justly maintained, and in this he was upheld by Mr. Agassiz, that the cost of any engine was of slight account compared to its efficiency. Many experts have doubted if this holds true for hoisting engines, on account of the irregularity of the load. It is only of recent years that it has been generally acknowledged that high efficiency hoisting engines justified their expense.

The "Superior," installed in 1883, was the largest hoisting engine Mr. Leavitt built for the Calumet and Hecla. It was an inverted compound beam engine with cylinders 40′ and 70′ in diameter. The fly wheel and the belt wheel were both 36 ft. in diameter. This engine was designed to hoist six four ton skips from a depth of four thousand feet, and also to run four Rand compressors. As this was vastly in excess of the needs of the day, the engine was looked on as a foolish monster by many people. In 1911 it was hoisting five ton skips from a depth of six thousand feet, and it is still doing efficient work to-day.

The steam stamps that Mr. Leavitt designed for the Calumet and Hecla marked a very distinct advance in the construction of such machinery. The distinctive feature of these stamps is a steam cylinder with two pistons, one with steam on top to give the blow, while under the other is a constantly applied reduced pressure to lift the stamp, the steam being forced back to the boiler with each blow.

Mr. Leavitt was not inclined to talk of his achievements. Once when he was asked how he got the idea of the Leavitt stamp, he replied: "One day in the Calumet mine, I stepped on the man engine at the twentieth level to go to the surface. I had no thought how to meet the problem at the moment. But when I stepped off, about twenty minutes later, the whole scheme was clear in my mind." To properly appreciate this feat, one should realize that the man engine, now obsolete, offered an absorbing and somewhat hazardous method of transportation, which fully occupied the attention of most people making use of it.

One of Mr. Leavitt's pumping engines for the Calumet and Hecla mills, had a capacity of sixty million gallons in twenty-four hours. It remained the largest pump of its day, until superseded by an engine of seventy-five million gallons per twenty-four hours, designed by Mr. Leavitt for the sewer works of the City of Boston.

His designs for Calumet included sand wheels of metal, instead of wood, the construction previously used in Northern Michigan. Two such wheels, built like bicycle wheels, had diameters of fifty and sixty feet.

Until ill health caused his retirement from business in 1904, Mr. Leavitt continued to act as consulting mechanical engineer for the Calumet and Hecla Mine. But his activities were by no means confined to work for that company.

He acted as consulting engineer for Henry R. Worthington; developed their high duty pumping engine for the Dickson Manufacturing Co.; and assisted the Bethlehem Steel Co. in modernizing their plant and in introducing hydraulic forging.

He designed three huge pumping engines for the Boston sewage department; and pumping engines for the following city water works: Cambridge, Mass., New Bedford, Boston, and Louisville. That for the last named city broke all previous records for economy in consumption of steam.

A pair of engines which he designed for the Washington Mills at Lawrence, have been steadily at work since 1887. He designed the equipment of the El Callao Mining Co. of Venezuela. The first engines of the cable railway of the Brooklyn Bridge came from the drawing boards of his remarkably efficient and well organized office in Central Square, Cambridgeport.

Mr. Leavitt's fame as a mechanical engineer was international, and during his frequent visits abroad he established a wide circle of professional friends. He was on intimate terms with the Krupps, and was on board their yacht Rona at the opening of the Kiel Canal.

A roomy old fashioned house on the slope of the hill on Harvard Street, Cambridgeport, was Mr. Leavitt's home for many years. There he delighted to entertain the prominent members of his profession, and many eminent European engineers enjoyed his hospitality. He was an ardent church man, a man of broadly charitable instincts, and widely known for the liberality of his gifts.

He was distinguished for an exceptional command of English, which was evident to a casual acquaintance. Although of a retiring character, his affectionate disposition and inborn geniality endeared him to all who were fortunate enough to penetrate his reserve.

Mr. Leavitt was one of the thirty founders of the American Society of Mechanical Engineers, and served as its president in 1882–83. He was a foreign member of several European engineering and scientific societies, and for many years was on the visiting committees of the Engineering Department, and of the Observatory of Harvard

University. He was elected a Fellow of the American Academy of Arts and Sciences in 1878, and long served on its Rumford Committee.

The last years of his life were passed in a house that he built for himself on Garden Street, Cambridge. Mr. Leavitt had worked so hard that he never learned to play; and although fondly cared for by his family, to whom he was devoted, and notwithstanding his interest in civic affairs, it is to be feared that time hung heavily on his hands, when he felt that his health demanded his retirement from business.

In 1867 he married Anne Elizabeth Pettit of Philadelphia who died in 1889. They had five children, the survivors being Mrs. Walter Wesselhoeft, Mrs. Paul Van Daell, and Miss Margaret A. Leavitt.

G. R. AGASSIZ.

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## PERCIVAL LOWELL (1855-1916)

Fellow in Class I, Section 1, 1892.

On both his maternal and paternal sides Percival Lowell came of stock prominent in the development of New England. The cities of Lowell and Lawrence were named for his ancestors. His father, Augustus Lowell, was a Vice President of the American Academy, his mother Katharine Lawrence was the daughter of a former Minister to Great Britian.

Lowell was born in Boston on March 13th, 1855, and fitted for college at "Noble's" school. He took honors in mathematics at Harvard and graduated *cum laude* in 1876. The elder Pierce spoke of him as one of the two most brilliant mathematicians whom he had seen at Harvard.

After leaving college he entered business in Boston. Unlike most devotees of pure science he possessed a marked gift for business matters, and became a force in the business world, where he occupied various positions of responsibility and trust.

From 1883 to 1893 he devoted his life chiefly to literature and travel. Much of this time was spent in the far East, chiefly in Japan, where for some years he made his headquarters in a charming native house in Tokio. He was appointed foreign secretary of the Special Mission from Korea to the United States, and conducted its travels